

NOTES ON THE BIOLOGY OF *TABANUS FROGGATTI*, *T. GENTILIS*, AND
T. NEOBASALIS (DIPTERA).

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(Plate x; thirteen Text-figures.)

[Read 25th August, 1937.]

TABANUS FROGGATTI Ric.
Systematics and Distribution.

Tabanus froggatti is a small, dark, hairy-eyed species, which was described by Ricardo (1915) from a female from Mr. Froggatt's collection. My specimens agree closely with one from Mr. Froggatt's series, and also with Miss Ricardo's description. But, in addition to the markings described by Ricardo, all specimens of *T. froggatti* which I have seen possess a large, triangular, tomentose, grey spot each side of the median spot on the second abdominal segment. This occurs in both sexes, but is obscured in greasy or rubbed specimens. The male, of which I have not been able to find a published description, differs from the female chiefly in having the upper facets of the eyes enlarged, the eyes densely clothed with black hairs, with some gold intermingled on the lower half, and in the possession of very long black hairs on the first two antennal segments. The whitish pubescence of the female is replaced by gold in the male, and the small median spots on the abdominal segments are clothed with gold hairs. The eyes of the female are bronzy green, and of the male bright emerald-green when alive. In general the male has a darker appearance than the female, owing to the profusion of black hair on the thorax and abdomen, and is larger, although there is considerable variation in the size of both sexes. The largest male was 14 mm. long, and the smallest female 8 mm.

The type and another specimen from Mr. Froggatt's collection are from the south coast of New South Wales. The only other distribution record known to me is Canberra.

Notes on Life-History and Habits.

The adults of *Tabanus froggatti* are on the wing in Canberra during October and November. They are very numerous in the vicinity of Black Mt. (2,668 ft.) during these months. Both sexes may be taken feeding on small flowers among the pasture, and also on low-growing *Leptospermum* on the hill slopes. The females attack cattle and humans, but are not as quick and strong in flight as many other biting species. They hover over and alight on swampy ground, crawling over mud and grass, and do not appear to drink while flying but when standing on the edge of small pools. During the second week in October, 1936, the flies were extremely numerous, swarming on the grass and worrying cattle. They were only active on bright, calm days.

Females bred in captivity refused to bite, and only a small proportion of the captured flies kept in cages bit readily. One female fed to repletion on my arm on 20th Oct., took a smaller feed on 21st and 22nd, but would not feed again (Plate x, fig. 2). A number of captured flies of both sexes were put into a field cage with food and water, and a rat was provided for blood feeds. Under these conditions the flies lived no longer than 8 or 9 days, and no egg masses were produced. Cameron notes that in British and North American Tabanids only fertilized females will bite, and in the case of *Haematopota pluvialis* it is exceptional for the female to bite more than once before oviposition, which takes 6 to 12 days after the feed.

The larvae of *T. froggatti* were found in the soil on the slopes of Black Mt. (Plate x, fig. 1). They were most abundant in the banks of a permanent swamp caused by the outflow from a septic tank, but were also found adjacent to small transient swamps produced by the drainage from taps. They live below the soil from just under the grass to a depth of two inches, and somewhat deeper on the banks of drains. When about to pupate they may be right on the surface among grass and debris. The larvae were found at various stages of development, indicating that they are never aquatic, but live in more or less moist soil all their lives. The larvae of *T. froggatti* were much more abundant than *T. neobasalis*, which occurred with them, and have not been found elsewhere than Black Mt. They were always obtained by digging and turning the soil, and breaking the clods. None were found by sieving wet mud, or by netting in the water among weeds and algae.

The larvae were present in the soil from 15th August to 10th October, 1935, and during September, 1936. As many as 20 may be dug out in half an hour near the permanent swamp. For the last week of collecting, practically all the larvae found were prepupal, and later digging yielded only pupae, which could be found until November. During May and June, 1936, a few large larvae were dug from the soil beneath sheep carcasses which had been lying since March on a higher, dry slope of the mountain. This part receives no drainage, and in summer is very dry, although the soil under the carcasses where the larvae were found was naturally somewhat moist.

The soil in which the larvae occurred harboured also numerous earthworms, a few Calliphorid larvae, and some larvae of the Tipulid, *Ischnotoma* species. *T. froggatti* attacked earthworms and soon destroyed those supplied as food. When kept in one container they readily bite and feed on each other, and when handled struggle vigorously, thrusting out the mandible and maxilla on one, or occasionally both, sides with a distinct clicking sound.

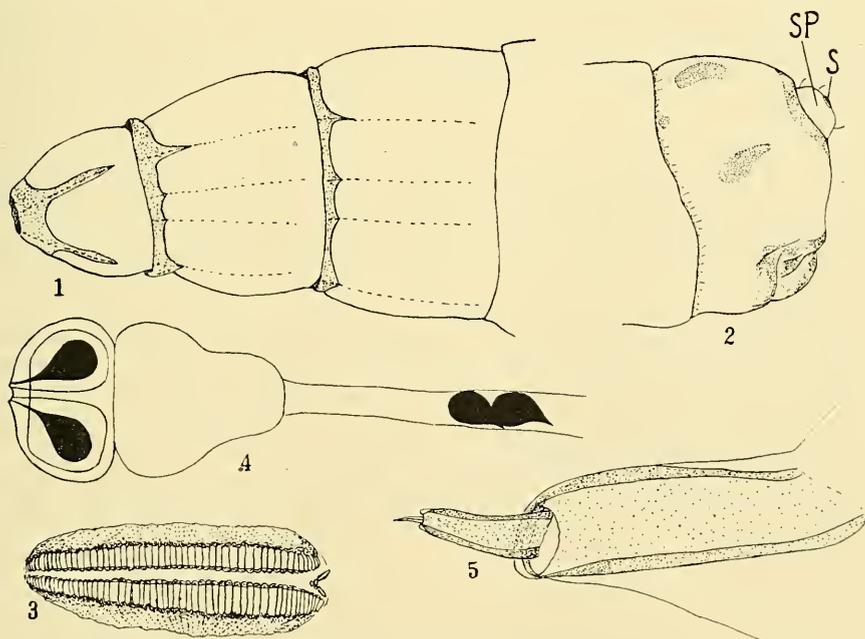
The length of the larval life is not known, but the evidence available indicates that the life cycle occupies one year. The larvae seem to reach full growth in summer and autumn, remain in a dormant state through winter, then feed again in spring before pupating.

The Larva (Plate x, figs. 5, 6).

The smallest larva was 11 mm. and the largest 22 mm. in length, with every gradation between. They were measured after being killed, being slightly longer when alive and fully extended. The following description is taken from a live larva: The skin is shining, and strongly, evenly and coarsely striated. It is sufficiently transparent for the internal organs to be visible. There is no pigment in the skin, which is uniformly cream to pale yellowish, often with a greenish tinge. The spiracle is orange, and the mouth parts brownish in colour. The

complete head is visible through the skin of the thorax, and Graber's organ is readily distinguishable beneath the dorsal surface of the eighth abdominal segment. Certain rugose portions of the skin appear to be pale brown on freshly collected larvae, but this is due to the particles of soil adhering to them. The dorsal vessel contains a bright green granular material, which gives the appearance of a green median stripe. The stomach contents are the reddish colour of earthworms.

The larva is narrow and elongated, tapering both ends, but more noticeably at the anterior end. The thoracic segments have a band of finely rugose skin round the anterior border, that on the first segment being widest (Text-fig. 1). In each segment the dorsum is marked off by a pair of narrow projections of rugose skin running back from the anterior band, and the lateral areas are marked off from the ventral in a similar manner. The first segment has a central projection on the ventral area, whilst the second and third have a pair of ventral projections. The abdominal segments have not a complete anterior ring of rugose skin as have the thoracic segments, but there is a slightly raised transverse ridge, both dorsally and ventrally, just behind the anterior margin in the first seven abdominal segments. This ridge is covered with rugose skin, and on the ventral surface bears a pair of blunt prominences. In some larvae each of these is divided into two by a slight depression. Laterally there is a strong, blunt, rugose papilla, the pair on the first and seventh abdominal segments being less prominent than the others. The abdominal segments are divided into dorsal, lateral and ventral areas by fine lines of dots situated in slight furrows. These are spots where muscles are attached to the skin. The eighth abdominal segment is short and broad,



Text-figs. 1-5.—*Tabanus froggatti*.

1. Anterior end of larva (stained), $\times 20$.—2. Posterior end, $\times 20$.—3. Posterior spiracle, $\times 200$.—4. Graber's organ, $\times 200$.—5. Antenna, $\times 140$.

being a little less than half as long as the others (Text-fig. 2). The skin is more coarsely striated than the rest of the body. The large anus, situated ventrally, has prominent swollen lips, and is surrounded by a fleshy ridge of rugose skin. The segment slopes backwards from the anus to the small postero-dorsal prominence which bears the spiracle, and which represents the siphon of aquatic Tabanid larvae. The spiracular prominence is surrounded by a circle of rugose skin. A pair of small pilose patches occurs dorsally, with another pair laterally. In some larvae there is another very small patch anterior to and between the dorsal and lateral patches. The rest of the segment is evenly striated.

On the ventral surface of each thoracic segment and about the centre, a pair of small hairs arise, one each side of the mid-line. There are also a few minute hairs on the dorsal and lateral areas of the thoracic segments. The abdominal segments, with the exception of the last, bear a transverse series of six hairs ventrally, in the anterior half, and there is a similar series of weaker hairs dorsally, and four on the lateral areas.

The spiracles. (Text-fig. 3.)

The tracheal trunks converge towards the spiracular prominence in the eighth abdominal segment. When they enter the prominence each ends in a large, laterally compressed felt-chamber, these being closely coherent. Through a vertical slit in the skin of the prominence the stigmata emerge as a pair of curved ridges crossed by a series of chitinous bars, giving them a "scalloped" appearance. The edges of the slit are marked by a row of tiny finger-like protuberances. These, with the stigmata and the felt-chambers, are coloured orange. The slit may be closed against the stigmata or expanded outwards, allowing an air passage down each side, called the "Vorraum des Stigmas" by Stammer (1924). The spiracular prominence bears small setae in groups of three. A pair of these occur at the upper and lower corners, and a smaller one just below the middle, each side of the spiracle.

The anterior spiracles are only visible with the naked eye when the larva is about to pupate, and the head is permanently withdrawn. They are a pair of slender lateral tubes projecting straight out from the first thoracic segment near its posterior margin. The surface shows a curved stigma with a scalloped appearance as in the posterior spiracle. The felt-chamber runs the length of the external tube.

The skin of the larva is of three layers: the outer thick striated skin, a median smooth glassy layer and a thin elastic inner layer. Special muscles attached to the skin cause a pattern of small dots on the surface in the slight furrows separating the various regions of the segments. The other muscles are attached beneath the rugose parts of the skin. The rugose skin is formed by the pinching up of the surface into wavy ridges, each ridge being finely papillate, with some approaching more to setose, the small projections varying from blunt to sharp pointed. All are directed backwards. The form of this skin is the same in every part where it occurs, but in places it is more finely ridged and papillate than in others.

Graber's organ. (Text-fig. 4.)

This is visible under the skin of the dorsal surface of the eighth abdominal segment, just anterior to the spiracular prominence, and opens to the surface through a tiny funnel-shaped depression at the junction of the eighth segment and the prominence. The surface of the body is curved here and the opening

is only visible from the posterior view. The organ consists of a small terminal chamber divided into two by a longitudinal vertical wall, each division containing a round black body attached to the top end by a stalk. Behind the terminal section is an empty pear-shaped chamber from which a long narrow tube runs to the opening, and contains two detached black bodies near the posterior end. All the black bodies are the same size. In all the Tabanid larvae examined Graber's organ was the same, probably the normal condition for the last instar.

The head.

The head when withdrawn reaches the posterior edge of the second thoracic segment, and when the segments are also contracted and telescoped it reaches the first abdominal segment. When fully extended it just projects into the second thoracic segment. There is an extension of the finely rugose skin of the fore-border of the first thoracic segment, which forms a thin membrane over the head to the base of the mouth parts. When the head is withdrawn, this membrane forms a long invaginated tube with the mouth parts at the bottom.

The epicranium consists of smooth chitin, heavily pigmented in the posterior two-thirds, especially towards the sides, and with the dark brown marking produced back into two fine points posteriorly where the plate fuses with the ends of the tentorial rods. Anteriorly the epicranium curves round the sides to form the lateralia, and medianly it is produced into the rostrum. There is a black eye-spot on either side beneath the surface of the lateralia and on a level with the gular plate.

The hollow tentorial rods run the length of the head from the base of the mouth parts. They converge and take an upward curve near the anterior end just above the eye spots, and in this region are connected with the epicranium by a curved chitinous bar. Just behind the mouth parts the rods fork, the outer and shorter branch, which is strongly chitinized at the end, articulating with the base of the maxilla, and the inner and longer projects into the back of the closed buccal cavity. At the posterior end they expand into a thin wing-like portion which joins the end of the epicranium.

The chitinous pharynx runs from the labium beneath the tentorial rods in the centre of the head ventrally, for half the length of the head and then between the rods to the end, where it expands slightly. The floor is most heavily chitinized, appearing as a bar from the side. In cross-section the pharynx is V-shaped. The salivary pump is situated ventrally near the middle of the head. It is large, oval with a concave, strongly chitinized, upper surface and a thinner convex lower surface. A wide duct connects with the labium at the anterior end, and from the posterior end a duct leads to the glands. There are valve structures where these ducts join the pump.

The antenna (Text-fig. 5) arises from the end of an elongated plate of the lateralia. This plate projects from the surface and has well-defined limits, giving it the appearance of a basal segment of the antenna. The first antennal segment is elongate and cylindrical, with the apical segment very fine, pointed and bifid. The clump of spines which appears as a brown spot behind the base of the antenna is close to the inner side of the antenna.

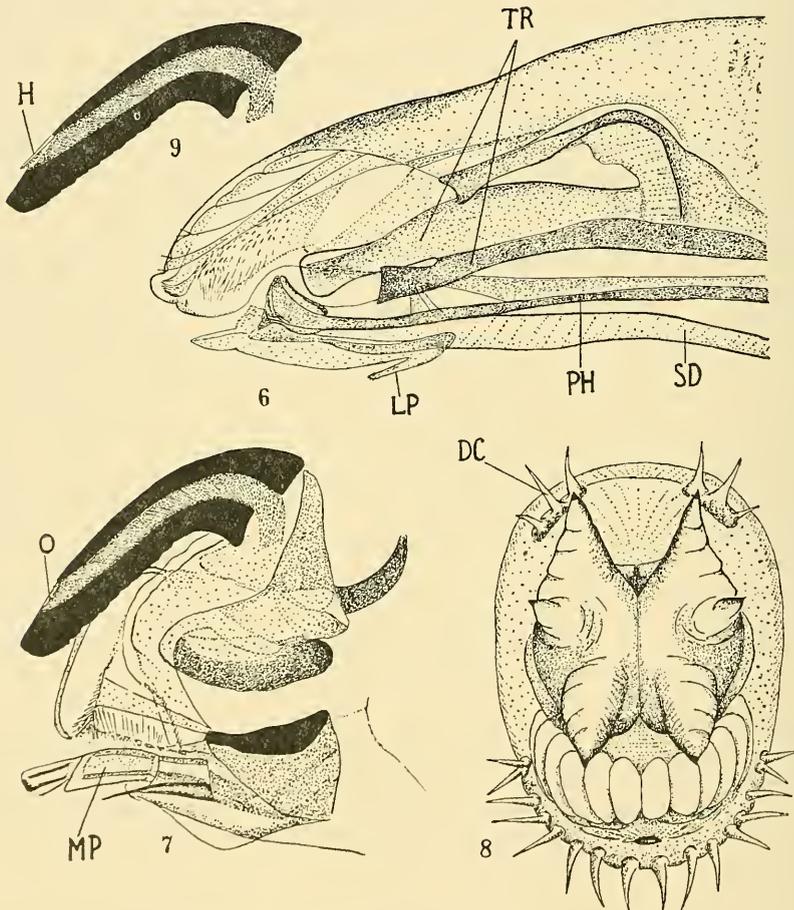
Mouth parts.

With the exception of the mandibles the mouth parts are of transparent, nearly colourless chitin. The most anterior point of the head is the up-turned tip of the labrum, which projects out between the mandibles. The labium, in touch with the lower surface of the labrum, does not extend so far forward. The mandibles lie close to the median labrum and labium, and outside and a little

below these are the maxillae, their palps extending in front of, below and slightly inside the antennae. Dorsally, between the base of the mandibles and the antennae, are the two bunches of "piercing spines".

The labrum (Text-fig. 6) is laterally compressed, with the upper edge most strongly chitinized and consisting of a down-curved narrow trough continuing from the rostrum. The anterior extremity is a small up-turned tip. On the ventral surface there is a small invagination where an upgrowth from the labium-pharynx projects. Just in front of this there is a region covered with hairs and small furrows. On the edges of the upper curved surface there are four pairs of sensory hairs arising from tiny pits.

The labium (Text-fig. 6) is a delicate dorso-ventrally flattened plate ending anteriorly in two pointed glossae, and bearing on the ventral surface near the



Text-figs. 6-9.—*Tabanus froggatti* and *T. gentilis*.

6. Labrum and labium, $\times 100$; *lp*, labial palp; *ph*, pharynx; *sd*, salivary duct; *tr*, tentorial rod.—7. Mandible and maxilla, $\times 140$; *o*, mandibular orifice; *mp*, maxillary palp.—8. Posterior end of male pupa, $\times 60$; *dc*, dorso-lateral comb.—9. Mandible of *T. gentilis*, $\times 140$; *h*, hair above orifice.

posterior extremity a pair of slender forwardly-projecting palps. The palp is one-segmented with a group of sensillae at the apex. The labium bears a few fine hairs on an upgrowth of the dorsal surface near the glossae. A large duct from the salivary pump runs into the labium and opens between the glossae on the dorsal surface. The upper surface of the labium is fused with the anterior end of the pharynx, there being a peg-like projection just behind the glossae attached to the lower surface of the labrum.

The mandible (Text-fig. 7) is composed of heavy black chitin, is slightly curved and has a blunt apex, behind which the longitudinal canal opens on the dorsal surface. It is strongly toothed along the lower concave surface. The maxilla (Text-fig. 7) is triangular in shape, of thin chitin, with the short rounded tip extending a little in front of the mandible. The anterior edge below the tip is fringed and haired. A large palp arises from the lower anterior edge. It has a short wide basal segment with an upgrowth bearing a hair on the outer side, a median elongated segment, and a short blunt apical segment. There are two thick chitinous sclerites at the base of the maxilla connected with the tentorium. A short curved bar, running from the outer surface at the back of the maxilla, also connects them with the bunch of spines, which are stiff, light brown, and simple or bifid.

The Pupa. (Plate x, fig. 3.)

The pupa is slightly curved throughout its length, the dorsal surface being convex. It is 14 to 16 mm. in length. When newly formed the colour is bright bluish-green, which changes with development to dull whitish-green on the abdomen and dark brown on the thorax and head. A few days prior to emergence the whole pupa becomes black. It is slender, the greatest width being approximately 4 mm. The shell left after emergence of the fly is of delicate, semi-transparent chitin.

The chitin of the head and thorax is wrinkled all over. On top of the head is a pair of prominences, each bearing a double bristle. On the back of the head there is another pair. Below the antennae on the ventral surface are two pairs of bristles, the upper pair being the further from the centre. Near the base of the leg-sheaths each side is a prominence bearing a double bristle, and laterally there is a bristle at the base of each wing-sheath.

The prominent ear-shaped mounds of the thoracic spiracles are dorso-lateral and just behind the eyes. The slit is in the form of a wide C. On the dorsum of the thorax are two pairs of large bristles. The narrow metathorax bears three pairs of bristles laterally. The tips of the wing-sheaths reach to the second abdominal segment. Each of the abdominal segments except the last is divided into dorsal, lateral and ventral areas by longitudinal furrows. The lateral region appears as a narrow ridge running the length of the abdomen. Near the centre of each segment on this lateral ridge is a spiracle in the form of a small backward-pointing projection, with a curved scroll-shaped slit, the opening of the scroll being anterior. Each segment except the last bears a girdle of spines on the posterior half. The first segment has only two pairs of spines dorsally and three laterally, in place of the complete circle of spines. Between the setose girdle and the posterior border of the segment the chitin is finely rugose, and there is a similar rugose band at the anterior border. The rest of the segment is much more coarsely wrinkled. The spines are long, stiff and straw-coloured, somewhat variable in length, with a series of very short spines in front of them,

The last abdominal segment bears the typical aster (Text-fig. 8) of six large pointed projections. The two lower and side arms are approximately the same size, with the upper pair slightly smaller. In the male the dorso-lateral combs have three bristles, two large and one small. These vary to some extent. There is a large anal tubercle with a continuous row of spines beneath. In the female pupa the arms of the aster are smaller and not so spreading, the bristles of the dorso-lateral combs are equal in size, the anal tubercle is small, and there is a median gap in the row of bristles beneath.

TABANUS GENTILIS Erich.

Systematics and Distribution.

Tabanus gentilis is very similar to *T. froggatti*, and doubtless often confused with it. The differences in the two species have been pointed out by Ricardo (1915). It appears to have a wider distribution than *T. froggatti*, being recorded from Barrington Tops, Kiandra, Kosciusko and Countegany, N.S.W.; Mts. Tidbinbilla and Tinderry, F.C.T.; and Tasmania. Taylor (1918) also records it from King George Sound, W.A.

Notes on Life-History and Habits.

T. gentilis has only been observed on the wing at Countegany (4,000 ft. approx.). It was abundant at the end of January, flying low over grass and swamps in a similar manner to *T. froggatti*, although it gave the impression of being a lighter-coloured fly. It was active only in bright sunlight, and attacked cattle and humans, being rather more persistent and stronger in flight than *T. froggatti*. This species was also collected feeding on *Leptospermum* and *Epacris* flowers in the swamps.

The larvae were only collected once, during October, 1936, near the summit of Mt. Tinderry (5,307 ft.). They occurred in dry soil, above and to the side of a swamp. The soil contained no earthworms, but numerous Bibionid larvae were present. They were very close to the surface under short grass, in the driest parts. Their remarkable abundance may be judged by the fact that an area approximately 15 by 4 feet yielded 36 larvae in an hour's digging.

The Larva.

The larva is very similar to that of *T. froggatti*, being distinguishable chiefly by the chalk-white colour, all the *T. froggatti* larvae seen being cream or yellowish. It differs also in being slightly more robust, in having more opaque skin, which is rather more coarsely striated, and in the rugose girdles and patches being more distinct and obvious. The details of the rugose marks and patches are the same as in *T. froggatti*. A close examination of the head and mouth parts revealed no essential differences from *T. froggatti*, with the exception of a small structure on the mandible (Text-fig. 9). This was noticed in *T. gentilis* only, and consists of a delicate setose-like projection arising from the posterior margin of the aperture on the dorsum of the mandible. It projects forwards across the pore, and has a series of fine hairs on the underside. It is frequently depressed, lying flush with the surface or pressed into the aperture. Although this structure has not been described in any other Tabanid mandible it is possibly present, being extremely difficult to detect when depressed into the pore. It could not be discerned with certainty in *T. froggatti* or *T. neobasalis*.

The Pupa.

This is essentially the same as in *T. froggatti*. The spines encircling the segments are slightly longer. The aster is the same in shape and structure, but

the dorso-lateral combs are larger, with the three spines approximately the same length, and longer than in *T. froggatti*. The distinguishing feature, however, is the presence of lateral combs, which are entirely lacking in *T. froggatti*. They are small rounded swellings, with ten to twelve short bristles.

TABANUS NEOBASALIS Tayl.
Systematics and Distribution.

T. neobasalis, which was redescribed from the type female and another specimen from Tamworth by Ricardo (1915), was originally given the name *basalis* by Walker. Taylor (1918) pointed out that Macquart had previously used *basalis*, and changed the name to *neobasalis*. Ferguson and Henry (1920) note that *T. neobasalis* is not always easy to distinguish from *T. circumdatus* in the field, but is usually rare.

My bred specimens agree with Ricardo's description. The male, which has not been described, differs from the female in having densely pubescent eyes, with the facets of the upper two-thirds enlarged. The hairs on the lower third are shorter and blacker, whilst those on the upper part are longer and browner. The whole body is more densely haired, especially on the thorax which, in addition to the appressed gold hairs of the female, has a thick covering of long yellow and black hairs. The median pale marks overlying the black stripe of the dorsum of the abdomen are not usually so noticeable in the male as in the female. The eyes of both sexes are always dull brown. The length varied from 11 to 14 mm.

The species has been recorded from Canberra, Brindabella, Tidbinbilla, Wee Jasper, Yarrangobilly, Alpine Creek, Tamworth, Wolseley and Kendall.

Notes on Life-History and Habits.

Tabanus neobasalis is not so abundant in Canberra as *T. froggatti*, only occasional individuals having been observed and collected in the field. They occur in December and January. Females attack cattle, and are more elusive and swift in flight than *T. froggatti*. One fly was observed attempting to bite a sheep carcass.

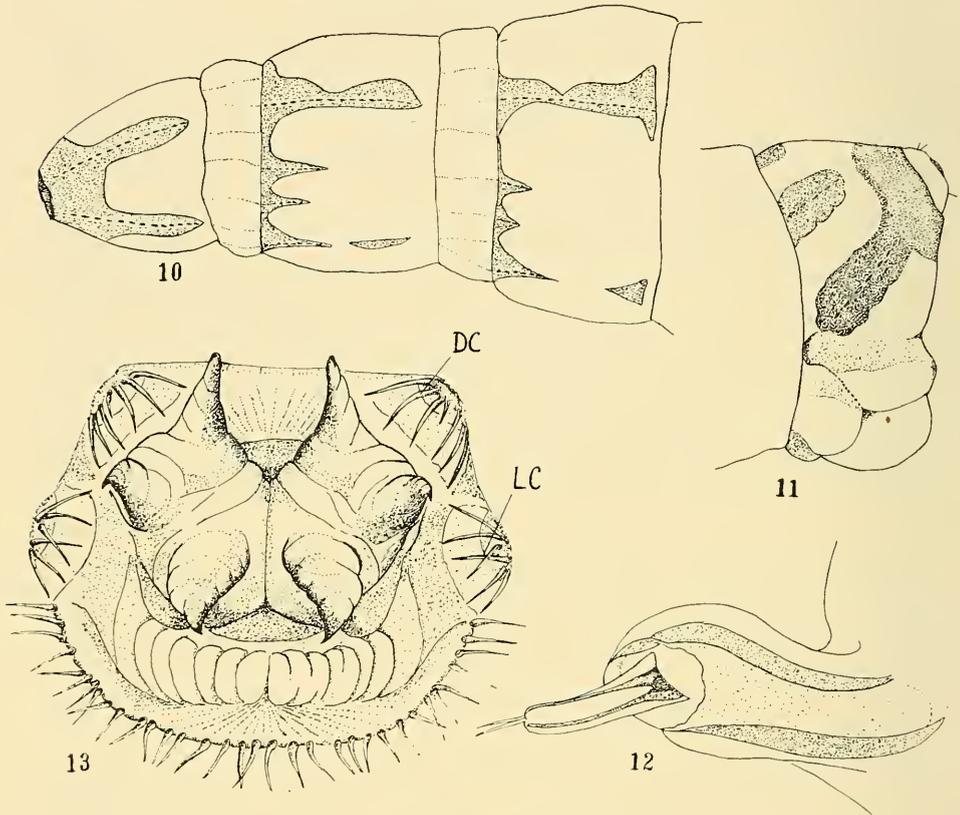
The larvae were found in company with those of *T. froggatti* from 14th August to 18th November, 1935, being present after *T. froggatti* had all pupated. They were more numerous in September, 1936, as many as six being dug up in half an hour. They were also found on the edges of swamps at Mt. Tidbinbilla (5,124 ft.), Mt. Coree (4,663 ft.), and Mt. Tinderry (5,307 ft.). Like *T. froggatti*, they were found only in soil and never in mud. The feeding habits were not observed, but the larvae were always associated with earthworms.

Of several pupae collected in the field one produced a small parasite, which was later identified as a species of *Spilomicrus*.

The Larva. (Plate x, figs. 7, 8.)

The larva is thicker and more robust in appearance than that of *T. froggatti*. The length of those examined varied from 14 to 23 mm., and the greatest width was 5 mm. The colour is deep cream to pale yellow, the skin is transparent and strongly and evenly striated all over except in certain hirsute areas. The striations are coarser than in *T. froggatti*, but the dark brown marks on the dorsal surface readily distinguish it from *T. froggatti*. There is no pigmentation as in *Scaptia* larvae, the colour of the marks being due entirely to the close massing of fine hairs, which vary from straw colour to a deep brown according to their position. The thoracic segments (Text-fig. 10) each have a wide, light brown hirsute band at the fore border, that on the first segment being much narrower than in

T. froggatti. In all the abdominal segments there is a posterior band of hairs as well. The marks on the thorax correspond to the pale lines in *T. froggatti*, which in that species are only clearly visible when stained. In *T. neobasalis* they are dark brown, the dorso-lateral pair being especially well developed.



Text-figs. 10-13.—*Tabanus neobasalis*.

10. Anterior end of larva, $\times 20$.—11. Posterior end, $\times 20$.—12. Antenna, $\times 140$.—13. Posterior end of male pupa, $\times 60$; *de*, dorso-lateral comb; *lc*, lateral comb.

On the abdominal segments there is a mid-dorsal dark brown spot on the anterior hirsute band, extending the width of the band and projecting on to the striated surface posteriorly, and the hind border of the previous segment anteriorly. Corresponding to the dorso-lateral lines in *T. froggatti* there are dark brown triangular marks projecting back from the hirsute band and forwards from the posterior border of each segment, their points approaching and in some old larvae and prepupae joining to form a longitudinal stripe. In most larvae they form a stripe on the seventh segment. The eighth abdominal segment (Text-fig. 11) has a pair of large dorsal patches corresponding in position to the dorso-lateral marks on the other segments, and a smaller central patch near the fore-border. In old larvae the dorsal patches extend to join the wide dark ring of hirsute skin surrounding the spiracular prominence. In all larvae a lateral

band connects this ring to the skin around the anus, which is hirsute, but lighter in colour than the dorsal patches. The anus and surrounding ridge is much larger and more prominent than in *T. froggatti*.

The spiracular prominence is striated, the striae curving and twisting in many directions. The hairs have the same arrangement as in *T. froggatti*, and are also in groups of three. The spiracles and felt-chambers are dark brown.

The rows of dots representing muscle attachments on the skin occur in the same position as in *T. froggatti*, and are associated with the dark brown marks. The actual spots are much larger. The rows of delicate hairs on the thorax and abdomen are similar to those in *T. froggatti*. Graber's organ is the same as in *T. froggatti*, and is visible from the dorsal surface, except in old larvae with extensive marks, lying between the posterior ends of the dorsal marks and in front of the ring round the spiracular prominence.

The head.

In general, the features of the head, tentorium and mouth parts are the same as in *T. froggatti*. There are, however, some slight differences in detail. The head and mouth parts are rather more strongly chitinized and are larger and stronger. The eye-spots are darker and more conspicuous. The salivary pump is larger and more elongated. The mandibles are longer, narrower and darker. The "piercing spines" form a larger and more noticeable spot, and they are individually longer and denser. Whereas these spines are simple or bifid in *T. froggatti*, in *T. neobasalis* they are bifid, trifid, and a few have four points, the main fork being long and the others smaller and spread out fan-wise. The wing-like posterior end of the tentorial rod has a thin strip of the chitin on its dorsal surface darkened, making a distinct mark. The labium has a more pronounced dorsal projection associated with the end of the pharynx, and the glossae are narrower and more pointed. The up-turned tip of the labrum is slightly different in shape, the dorsal trough is deeper, and the hairs longer. The under surface is much more hairy, there being a long fringe projecting from each side of the small pad in front of the junction with the pharynx, and a row of hairs along the sides where it roofs the buccal cavity. The antenna (Text-fig. 12) is similar to *T. froggatti*, but the first segment is slightly longer and narrower, and the bifid apex longer and stronger.

The Pupa. (Plate x, fig. 4.)

The pupa has the same shape as in *T. froggatti*, and is 15 to 17 mm. long and 5 mm. at its greatest width. It is darker in colour, has greenish tinges on the abdomen and dark brown to black shadings on the head and thorax. The chitin is thicker and firmer, and is shining and glossy, that on the thorax being smoother than in *T. froggatti*. The spines on the head and thorax are the same, but the anterior ring of smaller spines in front of the girdle of larger ones on the abdominal segments is better developed and more conspicuous, and the larger spines are longer and denser.

The chief differences are in the shape and size of the thoracic spiracles, which are larger and flatter than in *T. froggatti*, and of smoother, shining chitin, and in the details of the aster (Text-fig. 13). The slits of the abdominal spiracles are in the form of a wide C, rather than scroll-shaped as in *T. froggatti*. The dorso-lateral combs bear six bristles, and lateral combs also bearing six bristles are present in addition.

DISCUSSION.

The *Tabanus* larvae described above differ in three major characteristics from European and American species.

1. All other species described have the thoracic segments unstriated on the dorsum. Stammer (1924) uses this character in a key to genera. Under *Tabanus* he says, "the dorsal face of the thorax less striated than the rest of the body or completely free from longitudinal striations". Under *Hexatoma* he says, "thorax striated like the rest of the body", which latter description agrees with my larvae. Marchand (1920) states that the thorax is striated above in *Chrysops* and smooth or nearly so in *Tabanus*. In his general description of Tabanid larvae, Stone (1930) says that the striae of the skin are lacking in the dorsum of the thorax in *Tabanus*, and uses this character in a key to genera. Hill (1921), who described Queensland Tabanid larvae more like the European forms than mine, does not mention whether any of the species had the dorsum of the thorax smooth or striated. All his larvae were aquatic.

2. Another peculiar feature of the larvae of *T. froggatti*, *T. gentilis* and *T. neobasalis* is the truncated posterior end. All other *Tabanus* larvae described are pointed posteriorly, most having long siphons. Neave (1915) states that the abruptly truncated siphon is peculiar to the genus *Haematopota*, whilst in *Tabanus* the end of the anal segment forming the base of the siphon is long and tapered. The Australian *Tabanus* larvae figured by Hill and by Johnston and Bancroft (1920) have long siphons.

3. The larvae are definitely terrestrial, specimens of *T. froggatti* and *T. gentilis* even having been taken in quite dry soil, whereas most other known *Tabanus* larvae are aquatic, or at least semi-aquatic. It is possible that the first two peculiar features of the larvae are expressions of their unusual environment.

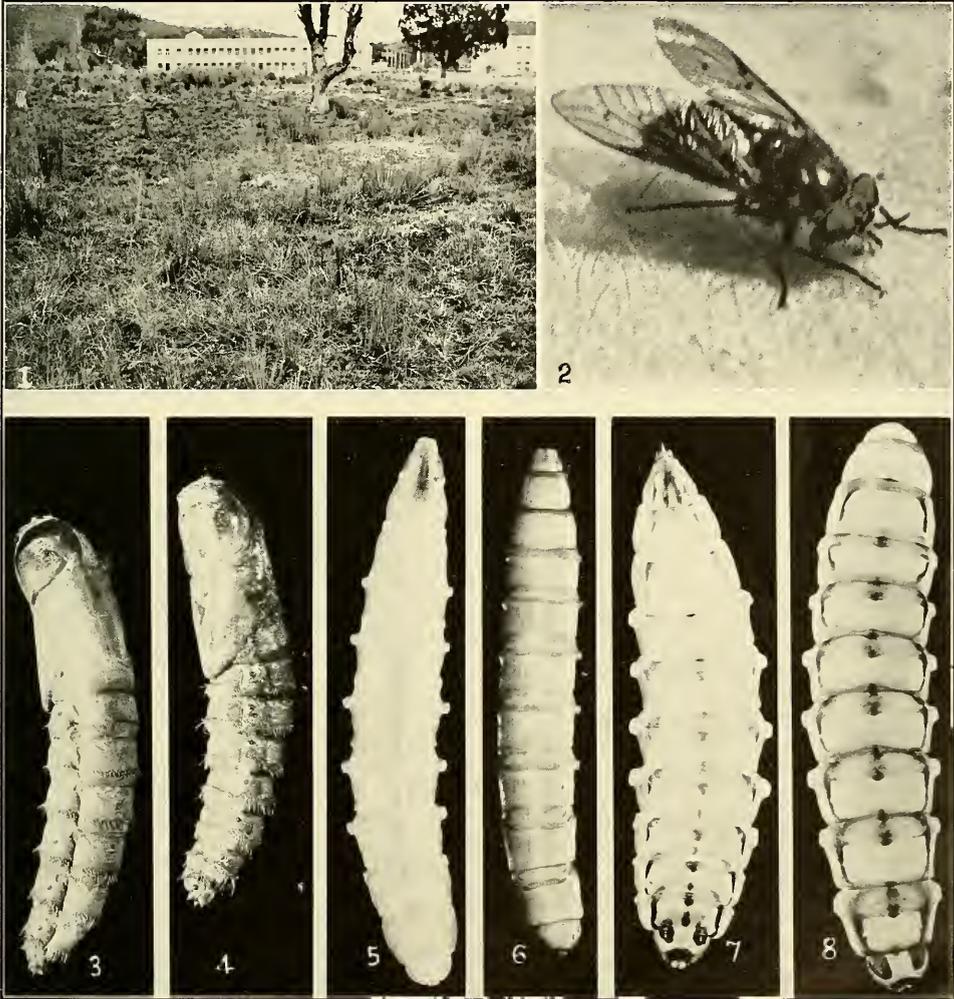
The Australian species of *Tabanus* fall into two main groups—the bare-eyed group which forms part of the Indo-Malayan element, appears to be related to the old world species, and to which the larvae described by Hill and by Johnston and Bancroft belong, and the hairy-eyed group constituting the sub-genus *Theriopectes*, which has a more southern distribution and would appear to belong to the Antarctic element of the fauna. It is difficult to find reliable adult characters to justify the separation of the two groups, the hairs on the eyes being exceedingly minute and sparse in certain species. The species described in this paper are typical *Theriopectes*, and the larval characters discovered support the separation of the hairy-eyed group, at least sub-generically.

Acknowledgements.

The author is indebted to Dr. I. M. Mackerras for information on the Tabanidae, and for assistance in the preparation of the paper, and to Mr. W. J. James for the photographs.

Bibliography.

- CAMERON, A. E., 1934.—The Life-History and Structure of *Haematopota pluvialis* Linné (Tabanidae). *Trans. Roy. Soc. Edinburgh*, lviii, 1, p. 211.
- FERGUSON, E. W., and HENRY, M., 1920.—Tabanidae from Camden Haven District, N.S.W., with Descriptions of New Species. *Proc. Linn. Soc. N.S.W.*, xlv, 4, p. 828.
- HILL, G. F., 1921.—The Bionomics of *Tabanus apreps* and other Australian Tabanidae. *Bull. Ent. Res.*, xvi, 4, p. 293.
- JOHNSTON, T. HARVEY, and BANCROFT, M. J., 1920.—Notes on the Life History of certain Queensland Tabanid flies. *Proc. Roy. Soc. Queensland*, xxxii, 10, p. 125.
- MARCHAND, W., 1920.—The Early Stages of Tabanidae (Horse-flies). *Monographs of the Rockefeller Institute for Medical Research*, No. 13, New York.



Tabanus froggatti (figs. 2, 3, 5, 6) and *T. neobasalis* (figs. 4, 7, 8).